GUIDELINES AND BACKGROUND TO THE CONTROL OF AIR, WATER AND LAND EMISSIONS FROM COUNTRY GRAIN AND FEED ELEVATORS

March, 1976

Ministry of the Environment

Ontario

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ONTARIO MINISTRY OF THE ENVIRONMENT

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STATEMENT OF INTENT

The primary purpose of these guidelines is to assist Ministry staff in the execution of abatement and approvals functions. They may also be used by industry as an indication of environmental control requirements.

These guidelines are supplementary to the "Guidelines and Criteria for Water Quality Management in Ontario", the "Objectives for the Control of Industrial Wastes Discharges in Ontario", and the requirements of The Environmental Protection Act pertaining to the emmission of air contaminants and the disposal of solid wastes. Details of Provincial noise control requirements are embodied in The Model Municipal Noise Control By-Law and its supporting technical publications which contain acceptable noise level limits applicable to industrial activity.

The guidelines reflect overall Ministry policy. They should be applied recognizing specific requirements of individual sites, alternate process and abatement technology, and the need to stage programs which will achieve the Ministry's goals in a rapid but realistic manner.

COUNTRY GRAIN AND FEED ELEVATOR GUIDELINES

INTRODUCTION

These guidelines are intended to apply to any new or existing country grain and feed elevators wherein the primary operation is to clean, to dry and to store grain before the grain is shipped to a livestock operator, cereal processor, distillery or terminal elevator.

Specific reference should be made to:

a) the Environmental Protection Act, Section 5, and Regulation 15 of the Revised Regulation of Ontario 1970, Section 5 and Schedule 1, Items 33 (Dustfall) and 73 (Suspended Particulate Matter),

b) The Objectives for the Control of Industrial Waste Discharges in Ontario (Effluent) such as the 5-day Biochemical Oxygen Demand (BOD_5) and Suspended Solids loadings,

c) the Model Municipal Noise Control By-law which may be adopted by the Municipality concerned. See Table B, page 25, for the desirable noise levels at the receiver.

A. W A T E R

There should be no effluent problem from a country grain and feed elevator. Water is used in the housekeeping of the elevator; that is the hosing down of dust and/or grain in the receiving/shipping areas, building/silo walls etc. The receiving/shipping areas are generally hard-surfaced, i.e., concrete or asphalt. Spilled grain is swept up for cleaning and processing before the residual grain and grain dust is washed into a storm sewer or ditch. Excessive discharges of grain and grain dust into a watercourse can cause elevated levels of BOD_5 and suspended solids.

B. A I R

1. Receiving Pit.

The rate of particulate emission is related directly to the capacity of the receiving pit. For very small receiving pits, 4 feet by 4 feet or less, the grain discharge from the truck should go through a hose or sock. Where a dump truck is used to deliver the grain, a large funnel-like attachment should be used to guide the grain into the hose.

For medium sized receiving pits, 6 feet by 6 feet or less, the truck and receiving pit should be in an enclosed area so that across the pit there is no air movement to carry particulate out of the enclosure. In existing country elevators with medium receiving rate pits, it may be physically impossible to enclose the receiving area without creating obstacles for good vehicle flow. In such a case, suction hooding connected by stationary or flexible piping to a fan and a collector should be provided.

For large or high rate receiving pits, in addition to an enclosed area, a suction system should be installed at the pit to convey the dust laden displaced pit air to a fabric filter collector. For existing country elevators with high rate receiving pits, it may not be possible to enclose the receiving pit without endangering vehicle flow. In such a case, a roof projecting over the receiving pit and suction hooding connected by a stationary or flexible piping to a fan and a collector may be required. For impingement calculations for this source the uncontrolled particulate emission rate is five pounds per ton of grain received.

2. Screening and cleaning.

Prior to venting to atmosphere, the air used in the screening and cleaning operations should vent through a fabric filter collector. For impingement calculations for this source, the particulate emission rate for the screening and cleaning operation which includes a cyclone is eight pounds per ton of grain handled.

3. Grain dryer.

The grain dryer emits particulate known as "bees-wings" or "red-dog" when processing corn. Preliminary reports indicate that the use of a burlap fabric filter will abate the gross emission of "bees-wings". Some fine particulate is still emitted through the burlap fabric filter. Control of dryer emission will be included in these guidelines when the University of Guelph dryer study is completed. Perforated metal walls and coarse screens have reduced "red-dog" emissions.

4. Shipping spout.

Grain should be loaded through an adjustable spout that has a hose or sock at the end. The spout should be continually adjusted so that there is a minimum free fall distance for the grain. If the spout cannot be adjusted, aspiration at the spout discharge should be provided. Particulate in the aspiration air should be collected. For impingement calculations for this source, the particulate emission rate is five pounds per ton of grain handled when a non-adjustable spout with no hose is used.

5. Storage bins/silos.

Where the discharge rate into a storage bin/silo exceeds 2,000 bushels/hour, the displaced air through the vent contains significant particulate and should go through a fabric filter which may be a weighted sock. For impingement calculations for this source, the uncontrolled particulate emission rate is two pounds per ton of grain handled.

6. Housekeeping.

Good housekeeping should be practised to minimize fugitive dust emissions. To enable good housekeeping practises, it may be necessary to pave areas such as driveways, receiving areas and shipping areas. After a dry sweep up of spilled grain, a hosing may be necessary for the final touch.

Where a central dust bin is part of the dust collection system, it should be possible to remove the accumulated

dust without creating a fugitive dust storm. It may be necessary to enclose the truck bay underneath the dust bin on three sides. The fourth side may be enclosed by doors or a canvas shroud with provision for the displaced air from the truck bin to go to the dust bin. If the collected dust is spouted to the truck bay by a chute, a moveable canvas sock or hose long enough to reach the bottom of the truck should be used.

TABLE OF EMISSION FACTORS FOR CALCULATING IMPINGEMENT CONCENTRATIONS

Source	Emission factor
Receiving Pit	5 pounds/ton of grain received
Screening and Cleaning	8 pounds/ton of grain handled
Shipping Spout	5 pounds/ton of grain handled
Bin/silo Vents	1 pound/ton of grain handled.

C. S O L I D W A S T E

Where the collected dust is disposed of in a landfill site owned by the country elevator, a Certificate of Approval from the Ministry of the Environment must be obtained for the operation of the landfill site. A good landfill operation should include a fence, gate, access road, layering and compacting of the waste, intermediate earth cover, grading and surface drainage control. Application for approval should be made to the Industrial Abatement Section, District Office, Ministry of the Environment.

If the solid waste material is disposed of at a municipally operated landfill site, the company may be required to exercise special precautions to avoid problems at the disposal site.

D. N O I S E

1. New elevators proposed within or near a residential area should meet the proposed 45 dBA noise level at the receiver during the night.

2. Existing elevators should meet the noise level specified by the municipality's land usage plan and/or Noise Control By-law.

The most significant stationary noise sources in a country feed and grain elevator are the grain dryer fans. This will be discussed in the grain dryer guidelines.

BACKGROUND TO

COUNTRY GRAIN AND FEED ELEVATORS GUIDELINES

A country grain and feed elevator can have a significant effect upon the air environment if the emissions are uncontrolled. In a country elevator grain is cleaned, dried and stored prior to shipping the grain to a livestock farmer, cereal processor, distillery or terminal elevator. With poor housekeeping, particulate fallout on the elevator will be wetted by rain and become odourous. In some instances, noise levels are a nuisance.

The design impingement concentration to be met is 100 micrograms of suspended particulate matter per cubic metre of air over a half hour period. This is the nuisance dust standard. Allowable concentrations of particulate that may cause health, plant or property damage are less than 100 micrograms per cubic metre over a half hour. The suspended particulate concentration in ambient air of small Ontario cities and towns is consistently below the geometric mean of 60 micrograms per cubic metre over a year.

Both the Environmental Protection Agency and the Department of Health, Education and Welfare in the United States agree that there is no evidence to show that health problems are caused by long term (decades) exposure to low concentrations (less than 100 micrograms per cubic metre) of airborne grain particulate to healthy people. However, extremely high concentrations of this particulate, especially if the particulate is all below five microns in size, can cause skin reactions, rashes etc., and respiratory ailments such as asthmatic attacks, i.e. baker's asthma. Particulate emissions from a country grain elevator cover a wide size range with very little below five microns. Individual health, inherited sensitivities, and personal habits for example cigarette smoking can result in the development of varying degrees of discomfort or illness in different people, even when all are exposed to identical airborne ambient concentrations and types of grain and feed particulate. The impingement of grain dust from the ambient air upon clothes, porch floor, car, etc., is a nuisance.

General

A country grain and feed elevator handles, conditions and stores grain which is moved from the farm to terminal elevators, various food processors and/or export markets. A country grain and feed elevator in general receives grains and/or soybeans when they are harvested within a 10 to 30-mile radius of the elevator. As well as cleaning grain, most country elevators will dry grain for storage. Some country elevators may shell the corn kernels from the cob. The terminal elevator, which has 15 to

500 times the grain storage of a country elevator, performs similar operations on grain received from many country grain and feed elevators. The difference between country elevator and terminal elevator is illustrated by the difference in the receiving rate of grain in bushels per hour. Most Ontario country elevators can receive grain at the rate of 400 to 2,000 bushels per hour; the terminal elevator at the rate of 30,000 to 35,000 bushels per hour.

The usual up-right country elevator consists of:

1. scales
2. a receiving pit which may include a truck lift for raising the front end of the truck
3. a bucket elevator or leg going up to the head house
4. a distributor head in the head house
5. storage bins prior to cleaning
6. cleaning equipment
7. a grain dryer
8. concrete storage silos
9. dust collectors
10. discharge spouts.

To simplify the operation and to minimize the use of mechanical equipment, maximum use is made of gravity flow in handling the grain.

The type of ownership generally indicates the amount of technical help available within the owner's organization. The owners of country elevators may be classified as follows:

Independent - family or individually owned

Cooperatives - controlled by farmer associations

Integrated - part of a food firm that provides seed to the farm, purchases his crop, processess the crop and sells the finished product to a retail outlet.

The type of pollution abatement proposed varies greatly reflecting the variation in technical skills available in this industry. Due to the range in size and in operation, individual abatement measures will probably be required for each elevator.

Almost all of the grain is brought to the country elevator by truck. While the bulk of the grain processed in Ontario is corn, other grains - soybeans, wheat, rye and oats - are also handled by the country grain and feed elevators. The usual grain flow is from farm to country elevator to terminal elevator. The maximum amount of activity occurs at harvest time for the country elevator; it is also the most likely time for complaints about particulate emissions and noise. In general, except for harvest time, very few country elevators operate at night.

Several country elevators may include a formula feed mill. The formula feed mill function is to grind and to mix a variety of whole grains to which may be added high protein concentrates, food industry by-products, vitamins, drugs, minerals etc. Formula feed mills will be covered in later guidelines.

A vertical column dryer is used to reduce the moisture level of the grain to a 15% moisture content. A large sized (over 1,000 microns) particle emission, known as red-dog or bees-wings, occurs during drying. At the same time particulate below 1,000 microns in size are emitted. The Ontario Ministry of the Environment has sponsored research at the University of Guelph regarding the dryer operation and its particulate emission. Upon completion of this study, guidelines will be issued.

Environmental Effects

The most significant effects upon the environment are caused by the particulate emissions from the country grain and feed elevator operations. A close second may be the effects due to the noise generated by process equipment and trucks; especially during harvest time when deliveries and operations go on around the clock.

Normally there should be no liquid effluent problem associated with a country elevator. The dust, corn cobs, stones etc., removed from the grain are taken to a landfill site; this part of the process may be a problem if care is not taken in handling the collected dust.

The two main noise sources associated with the country grain elevator are trucks and the dryer. In waiting to unload their grain, the trucks are kept idling. During harvest time,

trucks may be received around the clock seven days a week. Dryer noise is also part of the University of Guelph research project. Municipalities may adopt the Model Municipal Noise By-law which could result in the requirement that baffles are installed or the a centrifugal fan is used. Past practise has been to use inexpensive vane axial fans which are very noisy.

When a new country elevator is being located, consideration should be given to the surrounding land usage. A new country elevator located on large acreage in a rural area has a greater choice in abatement alternatives than an old grain elevator that is reactivated in an urban area. Locating a new country elevator in a residential area should be avoided. The severity of the dust and noise problems is closely related to the distance from source to receptor or home.

Dust Sources

The major dust source is usually the cleaning and screening operation in which large quantities of air are used to remove chaff, dust and dirt. The amount of air used in cleaning the grain can be varied by the operator depending upon the amount of corn cobs, weed seeds, small stones, dust, dirt, chaff, grain hairs, etc., in the grain. The basic design of the cleaners has not changed in fifty years; the cleaner fan is a low static pressure type. Adding a reverse jet bag filter may require a booster fan.

Some elevators have a corn sheller to remove the corn kernels from the cob. The cobs are stored in a dust bin; if the discharge system allows much free fall distance, the discharge of the cobs from the dust bin into a truck can result in a small dust storm. Recent installations use haul-away dust boxes which are used as dust bins. If an open top truck is used for dust removal, a cover should be put on the dust before the truck leaves the elevator.

Falling or moving streams of grain inspriate a column of air and cause the air to move in the same direction. When this moving mass of grain strikes an immovable object or changes direction, energy is expended and this causes extreme air turbulence. A violent generation of dust occurs. This situation exists when a large trailer truck unloads grain into the receiving pit hopper at the elevator; grain dust appears to "boil" up from the hopper. The amount of "boiling" depends upon the rate of unloading. A similar situation exists when trucks and rail cars are loaded; grain is spouted into the container to hit a wall which generates dust. When smaller trucks unload, a small gate is opened in the rear; dust is released as the grain passes through the gate. For such a

situation, a canvas hose controls the grain fall and will reduce emissions.

Lesser sources of dust emissions are conveying equipment and storage bins. When grain is conveyed, the grain kernels scrape and strike each other and the conveying equipment; this tends to rub off some of the chaff and break up some kernels. Belt conveyors have less rubbing friction than either screw or drag or bucket conveyors. Dust emissions usually occur at transfer points as materials fall onto or away from the transporting conveyor. The discharge points of pneumatic conveying equipment are also potential sources of dust emissions. Storage bins vent dust when the incoming material falls freely from a spout at the top of the bin, air is displaced and mixes with the dust as it is vented.

To enable good housekeeping practices, the receiving and shipping areas should be hard surfaced with either concrete or asphalt. Spilled grain should be swept up as soon as possible. At some country elevators in a town, during harvest time, a yard man continually sweeps up spilled grain and hoses down the remainder. Fugitive dust is thus minimized.

Where possible the waiting trucks during harvest time should be on country elevator property or away from homes. It is desirable to have a sound barrier of shrubs and trees between the idling trucks and the property line.

Collection Equipment for Grain Dust Emissions

The most frequently used types of dust control equipment are cyclones and fabric filters. In the past low or medium efficiency cyclones have been used in many feed and grain operations. These low pressure drop (less than one inch of water) cyclones are very efficient settling chambers for very large dust particles, stones, rocks, cobs, etc. The pressure drop across the cyclone indicates the approximate efficiency. For example, a 4-inch pressure drop cyclone is considered medium efficiency as 15 micron diameter or greater sized particles are collected almost 100%. An 8 to 10 inch pressure drop cyclone will collect almost 100% of all particles greater than 8 microns in size. High efficiency cyclones have a narrow inlet opening, a long body length relative to body diameter, and a small outlet diameter relative to body diameter. Bear in mind that these collection efficiencies must be related to the flowing specific gravity of the particles. Particles whose flowing specific gravity is one will be less efficiently collected than those whose specific gravity is four. It is the particles that are less than 10 microns in size that are readily airborne for great distances

and also can obstruct the opacity under certain lighting conditions. There are two problems with cyclones 1) that an opacity violation can occur due to the fine dust particles that are not collected, 2) the collection efficiency of a cyclone is very dependent upon the design air flow (a reduction in air flow rate decreases efficiency markedly), particle size (the smaller the particles, the lower the efficiency) and moisture content.

There are many fabric filter designs which vary in complexity and cost. A change in the dust load does not influence the maximum size of dust particle that escapes from a fabric filter. Dust particles are retained on the surface of the porous filter media while air passes through the openings. Regardless of the fabric cleaning mechanism, the openings in the fabric set an absolute maximum emitted particle size limit.

The simplest design is a fabric filter room where the four walls are fabric and the roof overhangs all walls by at least four feet. Usually the discharge from low efficiency cyclones is ducted into such a fabric filter room. Since this type of fabric collector is on the top of the dust bin or head house, it is often called a fabric penthouse. A maximum air to cloth ratio of 30 to 1 is recommended. The fabric should be a rot resistant fabric such as polyester or nylon. Yearly replacement may be necessary if burlap or cotton is used. Openings in the filter materials should be less than 50 microns in size. The material collected on the fabric improves the collection efficiency. The fabric filter should be supported in such a manner that the fabric can be flexed by the wind to shed the collected material. The pressure drop due to such a filter is probably unmeasurable. When the elevator is down, the collected material can be brushed/shovelled down a chute into a dust bin. The shovelling is a dusty operation and it may become difficult to persuade men to do this.

The next simplest type of fabric filter is the use of a hand shaken filter bag design. The fabric used in this design has openings less than one micron. The pressure drop in this design should be less than one inch water gauge. This requires considerably less space than the fabric filter house and eliminates a man to manually clean the dust.

The more complex type of fabric filter have either a mechanical (automatic) or reverse-air cleaning system. In the mechanical design, the collected dust is shaken or rapped

free of the fabric on a preset time cycle. The reverse air cleaning units use a felted fabric bag. The reverse air cleaning mechanism may be either a short compressed air jet or a low pressure reverse air blow. While these latter types are more costly, large air flows and dust flows are more readily handled by these compact collectors. Automatic reverse air type fabric filters with a maximum air-to-cloth ratio of 8:1 and a synthetic fabric such as polyethylene, dacron, etc., will probably be used in the long run throughout this industry.

Commercial baghouses are very efficient collectors of grain dust greater than one micron in size. The expected outlet dust load from such a baghouse is 0.03 grains per cubic foot of air or less.

It is customary engineering practice to pass air streams containing large quantities of dust through a cyclone prior to a fabric filter. This removes large particles and condensed moisture. This design relieves the fabric filter of handling an excessive volume of bulky materials and prolongs fabric life. Some grains have barbed or jagged hairs that may become entwined in the fabric and should go through a cyclone prior to a bag filter.

In addition to the fabric filter collector, it may be necessary to install a control system consisting of an enclosure, ducting and a fan. The receiving area (or dump pit) in the past has not been enclosed. For very effective dust control, suction should be provided at or just below the grate level and the dust laden air ducted to a collector. Several installations in Ontario have hood suction at each side of the receiving pit. This can be considered equivalent to providing suction below the grate. Many dup pit areas have been enclosed. The receiving area should be designed so that the doors can be easily closed to isolate a truck dumping its load from the waiting line of trucks. In some cases, automatic doors may be necessary. At high rate elevators, normally the dumping area has been enclosed, automatic door opening and closing has been provided and side suction hoods have been provided with the dust laden air going to a collector.

Status

Many existing country elevators have large, low pressure drop, low efficiency cyclones and a dust bin. Existing cyclones have resulted in infrequent opacity violations. Since the fabric filter collector, besides costing more, is an innovation for both owner and supplier, several elevators with reluctance have installed conventional baghouses. To extend bag

life, for some grain types, a precleaner like a cyclone is part of the baghouse system. Several fabric filter houses have been installed on the outlets of low efficiency cyclones. Reverse air baghouse collectors are being tried in several elevators.

Elevator operators, through their Association - The Ontario Feed and Grain Dealers - have expressed their concern and interest in abating environmental problems. The association persuaded the University of Guelph to study the grain dryer and its particulate emission. Several collection systems have been inspected and reported upon by their Technical Committee.

The particulate emission rate provided in the Guidelines For Control Of Air, Water and Land Emissions From Country Grain Elevators is from the United States Environmental Protection Agency data. These numbers have been changed and will probably be changed several times as it is very difficult to decide what is a representative emission rate for the different sources in a country feed and grain elevator. It is recognized that the actual emission rate from a country elevator can vary from truckload to truckload of grain, from corn to beans, etc., and from harves to harvest depending upon the weather. Rather than have every country elevator involved in prolonged stack sampling, the most probable emission rates are given in the Guidelines. Money that would have been spent on stack sampling in many cases is equal to the cost of control equipment. If assistance is required in evaluating the priority of abating the various sources in the country elevator, the Industrial Abatement Section of the local District Office, Ministry of the Environment should be contacted.

It is Ministry policy to require country grain and feed elevators that cause an environmental crisis in the community to take immediate corrective measures. The variation in emission rates, the availability of technical help, industry economics, recognition that this is the first commercial stage of processing grain and the technology available to this industry is acknowledged. THERE IS NO INTENTION TO REQUIRE ALL EXISTING COUNTRY ELEVATORS TO MEET THE 100 MICROGRAMS STANDARD BY A COMMON DATE. As the existing elevators undergo an expansion or modernization stage, the grain elevator should be brought into compliance at that time. If justifiable circumstances exist, only the process stage being constructed or modernized should be in compliance upon completion of construction. Other emissions, if it is necessary, are part of an abatement program. This may involve an extended program approval. New country elevators should comply with regulations upon completion of construction.